CLAIMS

What is claimed is:

1. A method for operating a superconducting magnet system, comprising:

monitoring a duty cycle of a heating element that supplies heat to the superconducting magnet system;

comparing the duty cycle to a predetermined value; and

providing an indication of a condition of the magnet system based upon the comparison.

2. The method of claim 1, wherein the duty cycle represents the periods of time that the heating element is energized and is expressed in percent of the time the heating element is energized;

wherein the periods of time are non-uniform lengths of time and amplitude of energization is substantially constant; and

wherein the heating element is configured in an on/off control scheme and is a constant heater when energized.

3. The method of claim 1, wherein the predetermined value of the duty cycle generally corresponds to an operating norm of the duty cycle and a specified tolerance is 50 percent of the predetermined value.

4. The method of claim 1, further comprising notifying a technician or alarming when the duty cycle falls outside a tolerance; and

wherein the duty cycle is monitored remotely and is used as a variable to determine when the superconducting magnet system is to be serviced.

5. The method of claim 1, further comprising identifying the one or more root causes of changes in the duty cycle.

6. The method of claim 1, wherein amplitude of energization varies and the heating element is a variable heater in a proportional-integral-derivative (PID) control scheme.

7. The method of claim 1, wherein the amplitude of energization varies and the periods of time the heating element is energized are constant.

8. The method of claim 1, wherein the superconducting magnet system provides one or more magnetic fields in a magnetic resonance imaging (MRI) system.

9. The method of claim 1, further comprising monitoring pressure in a cryogen vessel disposed in the superconducting magnet system; and

wherein the monitored pressure is used as a variable in determining when the superconducting magnet system is to be serviced.

10. A method for monitoring a superconducting magnet system, comprising:

monitoring an energization of a heating element that supplies heat to a superconducting magnet system;

comparing the energization to a specified tolerance; and

indicating when the energization falls outside the specified tolerance.

11. The method of claim 10, wherein the energization is controlled, monitored remotely, and used as a variable to determine when the superconducting magnet system is to be serviced.

12. The method of claim 11, wherein indicating when the energization falls outside the specified tolerance comprises at least one indicia of a signal to an indicator or indicator system, an audible alarm, a signal to a control system, an indicating light on a graphical-user interface, and an electronic message.

13. The method of claim 11, wherein the superconducting magnet system is repaired or re-configured in response to indication of the energization falling outside of the specified tolerance and to conform the energization to within the specified tolerance.

14. The method of claim 10, wherein the superconducting magnet system provides one or more magnetic fields in at least one of a magnetic resonance imaging (MRI) system, nuclear magnetic resonance (NMR) system, and a spectroscopy system.

15. A method for operating a superconducting magnet system, comprising:

monitoring a duty cycle of a pressure control circuit that controls pressure in a cryogen vessel in the superconducting magnet system;

comparing the duty cycle to a predetermined value; and

providing an indication of a condition of the magnet system based upon the comparison.

16. The method of claim 15, wherein cryogen vessel holds a helium liquid pool that surrounds one or more magnets in the superconducting magnet system.

17. A superconducting magnet system, comprising:

a cryogen vessel that contains or surrounds one or more magnets disposed in the superconducting magnet system;

a heating element disposed within the cryogen vessel;

a heater controller for controlling energization of the heating element which vaporizes a cryogen liquid disposed in the cryogen vessel;

a monitoring system comprising one or more interfaces and one or more sensors for remotely monitoring the energization of the heating element; and

one or more indicators for indicating when the energization falls outside a predetermined tolerance.

18. The system of claim 17 further comprising a relief device disposed on or near the cryogen vessel.

19. The system of claim 17, wherein the energization of the heating element is adjusted to control pressure in the cryogen vessel and to control temperature of the one or more magnets.

20. The system of claim 19, wherein the cryogen liquid comprises helium liquid.

21. The system of claim 20, wherein the pressure of the cryogen vessel is controlled in the approximate range of 4.0 to 4.5 psig and the temperature of the magnets is controlled at approximately 4 Kelvin.

22. The system of claim 18, further comprising a cold head for condensing cryogen vapor from the cryogen vessel, and wherein operation of the cold head affects cryogen pressure and thus affects the temperature of the one or more magnets.

23. The system of claim 22, wherein the heater controller is configured for at a constant heater in an on/off control scheme with constant amplitude energization while the heater is on and the heating element is energized.

24. The system of claim 23, wherein periods of time the heating element is energized are non-uniform in length of time.

25. The system of claim 22, wherein the heater controller is configured for a variable heater in a proportional-integral-derivative (PID) control scheme with variable amplitude energization of the heating element.

26. A superconducting magnet system, comprising:

a heater controller that controls an energization rate of a heating element disposed within a superconducting magnet system;

a control system, one or more interfaces, and one or more sensors for remotely monitoring the energization rate of the heating element; and

one or more indicators for indicating when the energization rate of the heating element falls outside a specified tolerance.

27. The system of claim 26, wherein the superconducting magnet system is disposed within a magnetic resonance (MR) imaging system.

28. The system of claim 27, wherein the one or more interfaces for monitoring the energization of the heating element comprise at least one of a laptop, a computer, a workstation, a network connection, and a MR imaging system interface.

29. The system of claim 28, further comprising:

a cryogen vessel disposed in the superconducting magnet system and holding a cryogen at its boiling point for cooling one or more magnets;

a cold head configured for removing heat from the superconducting magnet and condensing cryogen vapor received from a vapor space of the cryogen vessel;

a refrigerant compressor system that supplies refrigerant to the cold head to cool the cold head; and.

a relief vent disposed in the superconducting magnet system for relieving cryogen vapor to control pressure and temperature within the superconducting magnet system

30. A system for operating a superconducting magnet system, comprising:

means for controlling and adjusting the energization of a heating element that supplies heat to the superconducting magnet system;

means for monitoring the energization of the heating element;

means for comparing the energization of the heating element to a predetermined value; and

means for providing an indication of a condition of the magnet system based upon the comparison.

31. The system of claim 30, wherein the means for controlling energization controls the temperature of one or more magnets disposed in the superconducting magnet system by controlling pressure within a cryogen vessel that surrounds the one or more magnets.

32. The system of claim 30, comprising means for remotely monitoring the energization of the heating element.

33. The system of claim 32, further comprising:

means for notifying a technician when the energization falls outside a specified tolerance;

means for identifying one or more root causes of changes in the energization; and

means for conforming the energization of the heating element to within the specified tolerance.

34. The system of claim 30, further comprising:

means for relieving pressure and cryogen vapor from the superconducting magnet system;

means for condensing the cryogen vapor disposed within the superconducting magnet system and for removing heat from the superconducting magnet system;

35. A system for monitoring a superconducting magnet system, comprising:

means for monitoring a duty cycle of a heating element that supplies heat to the superconducting magnet system;

means for comparing the duty cycle to a predetermined value; and

means for providing an indication of a condition of the magnet system based upon the comparison.

36. The system of claim 35, wherein the superconducting magnet system is disposed in at least one of a magnetic resonance imaging (MRI) system, nuclear magnetic resonance (NMR) system, and a spectroscopy system.

37. The system of claim 35, further comprising means for controlling energization of the heating element.

38. The system of claim 37, comprising means for controlling the amount of time the heating element is energized, and wherein duty cycle is defined as the percent of time that the heating element is energized.

39. A computer program, provided on one or more tangible media, for operating a superconducting magnet system, comprising:

a routine for controlling and adjusting the energization of a heating element that supplies heat to the superconducting magnet system;

a routine for remotely monitoring the energization of the heating element;

a routine for comparing the energization of the heating element to a predetermined value; and

a routine for providing an indication of a condition of the magnet system based upon the comparison.

40. The computer program of claim 39, further comprising:

a routine for notifying a technician when the energization falls outside a specified tolerance.

41. A computer program, provided on one or more tangible media, for monitoring a superconducting magnet system, comprising:

a routine for monitoring a duty cycle of a heating element that supplies heat to the superconducting magnet system;

a routine for comparing the duty cycle to a predetermined value; and

a routine for providing an indication of a condition of the magnet system based upon the comparison.

42. The computer program of claim 41, further comprising a routine for controlling energization of the heating element.